

**THAT WHICH IS CLAIMED:**

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1. A method for carrying out a catalysis reaction in carbon dioxide, said method comprising:

5 contacting a fluid mixture with a catalyst bound to a polymer, the fluid mixture comprising at least one reactant and carbon dioxide, wherein the reactant interacts with the catalyst to form a reaction product.

10 2. The method according to Claim 1, wherein the carbon dioxide is gaseous carbon dioxide.

15 3. The method according to Claim 1, wherein the carbon dioxide is liquid carbon dioxide.

4. The method according to Claim 1, wherein the carbon dioxide is supercritical carbon dioxide.

20 5. The method according to Claim 1, wherein said contacting step comprises a reaction taking place selected from the group consisting of a <sup>300/250+</sup>hydrogenation reaction, a hydroformylation reaction, a epoxidation reaction, and a carbon-carbon coupling reaction.

25 6. The method according to Claim 1, wherein the catalyst comprises a transition metal.

30 7. The method according to Claim 6, wherein the transition metal is selected from the group consisting of ruthenium, rhodium, palladium, platinum, vanadium, molybdenum, and a fluorosoluble material.

8. The method according to Claim 1, wherein the catalyst is an enzymatic catalyst.

9. The method according to Claim 8, wherein the enzymatic catalyst is selected from the group consisting of alcohol dehydrogenases, alcohol oxidase, aldolase, phosphatases, alpha-chymotrypsin, asparaginase, anhydrase, catalase, creatine kinase, glutaminase, oxidases, lipases, luciferase, urease, hydratase, peroxidase, subtilisin Carlsberg and BPN', thermolysin, superoxidase, nitrileamidase, esterases, transaminase, trypsin, fumarase, amidase, acylase, peptidases, carboxylases, RNAses, glycolases, transeferases, enzymes derived from microbial sources, enzymes derived from plant sources, enzymes derived from animal sources, enzymes derived from extremophiles, and mixtures thereof

10. The method according to Claim 1, wherein the polymer is soluble in carbon dioxide.

11. The method according to Claim 10, wherein the polymer comprises at least one carbon dioxide-philic group.

12. The method according to Claim 11, wherein the carbon dioxide-philic group comprises a group selected from a silicone-containing group and a fluorine-containing group.

13. The method according to Claim 11, wherein the carbon dioxide-philic group comprises a fluoropolymer derived from acrylate or methacrylate monomers.

14. The method according to Claim 1, wherein the polymer is insoluble and swellable in carbon dioxide.

15. The method according to Claim 14, wherein the polymer is formed from at least one monomer selected from the group consisting of styrenics,  $\alpha$ -olefins, ethylene oxides, dienes, amides, esters, sulfones, sulfonamides, imides, thiols, alcohols, diols, acids, ethers, ketones, cyanos,

amines, quaternary ammonium salts, acrylates, methacrylates, thiozoles, and mixtures thereof.

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16. The method according to Claim 14, wherein the polymer is a copolymer formed from monomers selected from the group consisting of styrenics,  $\alpha$ -olefins, ethylene oxides, dienes, amides, esters, sulfones, sulfonamides, imides, thiols, alcohols, diols, acids, ethers, ketones, cyanos, amines, quaternary ammonium salts, acrylates, methacrylates, thiozoles, 2-(N-ethylperfluorooctane- sulfonamido) ethyl acrylate, 2-(N-ethyl perfluorooctane- sulfonamido) ethyl methacrylate, 2-(N-methylperfluoro octane- sulfonamido) ethyl acrylate, 2-(N-methylperfluorooctane- sulfonamido) ethyl methacrylate, 1,1'-dihydroperfluorooctyl acrylate, 1,1'-dihydroperfluoro octyl methacrylate, 1,1',2,2'-tetrahydroperfluoroalkylacrylate, 1,1',2,2'- tetrahydroperfluoroalkyl- methacrylate,  $\alpha$ -fluorostyrene, 2,4,6- trifluoromethylstyrene, hexafluoropropylene oxide, perfluorocyclohexane oxide, tetrafluoroethylene, vinylidene fluoride, chlorotrifluoroethylene, perfluoro(propyl vinyl ether), perfluoro(methyl vinyl ether), alkyl siloxanes, fluoroalkyl siloxanes, chloroalkyl siloxanes, and mixtures thereof.

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17. The method according to Claim 14, wherein the polymer is a copolymer formed from a fluoroacrylate monomer and a monomer selected from glycidyl methacrylate and styrene.

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18. The method according to Claim 1, wherein the catalyst is bound to a ligand which is bound to the polymer at a plurality of locations along the chain of the polymer.



25. The composition according to Claim 21, wherein the catalyst comprises a transition metal.

5           26. The composition according to Claim 25, wherein the transition metal is selected from the group consisting of ruthenium, rhodium, palladium, platinum, vanadium, molybdenum, and a fluorous-soluble material.

10           27. The composition according to Claim 21, wherein the catalyst is an enzymatic catalyst.

28. The composition according to Claim 27, wherein the enzymatic catalyst is selected from the group consisting of alcohol dehydrogenases, alcohol oxidase, aldolase, phosphatases, alpha-chymotrypsin, asparaginase, anhydrase, catalase, creatine kinase, glutaminase, oxidases, lipases, luciferase, urease, hydratase, peroxidase, subtilisin Carlsberg and BPN', thermolysin, superoxidase, nitrileamidase, esterases, transaminase, trypsin, fumarase, amidase, acylase, peptidases, carboxylases, RNases, glycolases, transeferases, enzymes derived from microbial sources, enzymes derived from plant sources, enzymes derived from animal sources, enzymes derived from extremophiles, and mixtures thereof.

29. The composition according to Claim 21, wherein the polymer is soluble in carbon dioxide.

30. The composition according to Claim 29, wherein the polymer comprises at least one carbon dioxide-philic group.

31. The composition according to Claim 30, wherein the carbon dioxide-philic group comprises a group selected from a silicone-containing group and a fluorine-containing group.

32. The composition according to Claim 30, wherein the carbon

dioxide-philic group comprises a fluoropolymer derived from acrylate or methacrylate monomers.

5            33.    The composition according to Claim 21, wherein the polymer is insoluble and swellable in carbon dioxide.

10            34.    The composition according to Claim 33, wherein the polymer is formed from at least one monomer selected from the group consisting of styrenics,  $\alpha$ -olefins, ethylene oxides, dienes, amides, esters, sulfones, sulfonamides, imides, thiols, alcohols, diols, acids, ethers, ketones, cyanos, amines, quaternary ammonium salts, acrylates, methacrylates, thiozoles, and mixtures thereof.

15            35.    The composition according to Claim 33, wherein the polymer is a copolymer formed from monomers selected from the group consisting of styrenics,  $\alpha$ -olefins, ethylene oxides, dienes, amides, esters, sulfones,  
20    sulfonamides, imides, thiols, alcohols, diols, acids, ethers, ketones, cyanos, amines, quaternary ammonium salts, acrylates, methacrylates, thiozoles, 2-(N-ethylperfluorooctane- sulfonamido) ethyl acrylate, 2-(N-ethyl perfluorooctane- sulfonamido) ethyl methacrylate, 2-(N-methylperfluoro octane- sulfonamido) ethyl acrylate, 2-(N-methylperfluorooctane- sulfonamido)  
25    ethyl methacrylate, 1,1'-dihydroperfluorooctyl acrylate, 1,1'-dihydroperfluoro octyl methacrylate, 1,1',2,2'-tetrahydroperfluoroalkylacrylate, 1,1',2,2'- tetrahydroperfluoroalkyl- methacrylate,  $\alpha$ -fluorostyrene, 2,4,6- trifluoromethylstyrene, hexafluoropropylene oxide, perfluorocyclohexane oxide, tetrafluoroethylene, vinylidene fluoride, chlorotrifluoroethylene,  
30    perfluoro(propyl vinyl ether), perfluoro(methyl vinyl ether), alkyl siloxanes, fluoroalkyl siloxanes, chloroalkyl siloxanes, and mixtures thereof.

36. The composition according to Claim 33, wherein the polymer is a copolymer formed from a fluoroacrylate monomer and a monomer selected from glycidyl methacrylate and styrene.

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37. The composition according to Claim 21, further comprising a ligand and wherein the catalyst is bound to the ligand which is bound to the polymer at a plurality of locations along the chain of the polymer.

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38. The composition according to Claim 37, wherein the ligand is selected from the group consisting of  $\beta$ -diketone, phosphate, phosphite, salen, bis imine, pyridine-bisimine, imidazole, pyrazolyl borate, pyridine, bi- and tripyridine, porphyrin, phthalocyanine, cyclopentadienyl, phosphonate, 15 phosphinic acid, phosphine, thiophosphinic acid, dithiocarbamate, amino, ammonium, hydroxyoxime, hydroxamic acid, calix(4)arene, macrocyclic, crown ether, 8-hydroxyquinoline, picolylamine, thiol, carboxylic acid ligands, chiral ligands, monodentate ligands, polydentate ligands, and mixtures thereof.

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39. A method of separating at least one component from a fluid mixture, said method comprising:

25 contacting a polymer with a fluid mixture comprising at least one component and carbon dioxide, wherein the carbon dioxide interacts with the polymer and separates from the fluid mixture such that the fluid mixture has an increased concentration of the at least one component.

40. The method according to Claim 39, wherein the at least one 30 component is selected from the group consisting of a  $C_1$  to  $C_8$  hydrocarbon, volatile organic contaminants, monomers, initiators, chlorofluorocarbons, mercaptans, water, nitrogen, a noble gas, hydrogen, and mixtures thereof.

41. The method according to Claim 39, wherein the carbon dioxide is gaseous carbon dioxide.

5 42. The method according to Claim 39, wherein the carbon dioxide is liquid carbon dioxide.

43. The method according to Claim 39, wherein the carbon dioxide  
10 is supercritical carbon dioxide.

44. The method according to Claim 39, wherein the polymer is  
formed from at least one monomer selected from the group consisting of  
15 styrenics,  $\alpha$ -olefins, ethylene oxides, dienes, amides, esters, sulfones,  
sulfonamides, imides, thiols, alcohols, diols, acids, ethers, ketones, cyanos,  
amines, quaternary ammonium salts, acrylates, methacrylates, thiozoles, and  
mixtures thereof.

20 45. The method according to Claim 39, wherein the polymer is a  
copolymer formed from monomers selected from the group consisting of  
styrenics,  $\alpha$ -olefins, ethylene oxides, dienes, amides, esters, sulfones,  
sulfonamides, imides, thiols, alcohols, diols, acids, ethers, ketones, cyanos,  
25 amines, quaternary ammonium salts, acrylates, methacrylates, thiozoles, 2-  
(N-ethylperfluorooctane- sulfonamido) ethyl acrylate, 2-(N-ethyl  
perfluorooctane- sulfonamido) ethyl methacrylate, 2-(N-methylperfluoro  
octane- sulfonamido) ethyl acrylate, 2-(N-methylperfluorooctane- sulfonamido)  
ethyl methacrylate, 1,1'-dihydroperfluorooctyl acrylate, 1,1'-dihydroperfluoro  
30 octyl methacrylate, 1,1',2,2'-tetrahydroperfluoroalkylacrylate, 1,1',2,2'-  
tetrahydroperfluoroalkyl- methacrylate,  $\alpha$ -fluorostyrene, 2,4,6-  
trifluoromethylstyrene, hexafluoropropylene oxide, perfluorocyclohexane  
oxide, tetrafluoroethylene, vinylidene fluoride, chlorotrifluoroethylene,



perfluoro(propyl vinyl ether), perfluoro(methyl vinyl ether), alkyl siloxanes, fluoroalkyl siloxanes, chloroalkyl siloxanes, and mixtures thereof.

5            46.    The method according to Claim 39, wherein the polymer is a copolymer formed from a fluoroacrylate monomer and a monomer selected from glycidyl methacrylate and styrene.

10           47.    A method for carrying out a catalysis reaction in carbon dioxide, said method comprising:  
              contacting a liquid or supercritical fluid medium with a catalyst bound to a polymer, the fluid medium comprising at least one reactant and wherein the reactant interacts with the catalyst to form a reaction product.

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              • 48.    The method according to Claim 47, wherein the fluid medium is selected from the group consisting of hydrofluorocarbons, perfluorocarbons, hydrocarbons, noble gases, and mixtures thereof.

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